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JULY 1994

DESCRIPTION OF THE "LIDAR.C VERSION 1.40" SOFTWARE INCORPORATED INTO AN AIRBORNE LIDAR SYSTEM TO DETECT TUNAS IN THE EASTERN TROPICAL PACIFIC PURSE-SEINE FISHERY

By

Charles W. Oliver

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National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii

ADMINISTRATIVE REPORT LJ-94-16

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Description of the "LIDAR.C version 1.40" software incorporated into an airborne LIDAR system to detect tunas in the eastern tropical Pacific purse-seine fishery.

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NOTE: Because most individuals will not have an immediate need to review the actual source code for the "LIDAR.C version 1.40" software and NMFS would like to reduce the cost of producing copies of Administrative Reports, **I have not included the "Program Listings" (Pages 19-106) in this abbreviated report. If you desire the complete listings to append to this report, please send a written request to:**

LIDAR Custodian
Southwest Fisheries Science Center
P.O. Box 271
La Jolla, CA 92038-0271.

"LIDAR.C version 1.40 Source Code Listings"
SWFSC Administrative Report No. LJ-94-16
Oliver 1994

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Introduction

A method of locating tuna when they are not associated with dolphins could be important in reducing or eliminating incidental dolphin mortality because dolphins are indicator cues for 60-90% of the annual eastern tropical Pacific tuna catch. LIDAR (light detecting and ranging) is a rapidly developing technology that offers potential for detecting fish schools deeper than current visual methods allow, detecting schools missed because of environmental and human factors (e.g., whitecaps, glare, fatigue, distraction) and detecting schools during the night as well as day. The Dolphin-Safe Program at the Southwest Fisheries Science Center initiated development of an airborne LIDAR system in 1990 (Young and Armstrong, 1992) as one part of a strategic plan to investigate alternatives to fishing methods that involve dolphins (DeMaster 1992).

Through a series of contracts, an airborne LIDAR system was developed, tested, and operated from a commercial tuna purse-seine vessel (Grams and Wyman, 1993; Oliver et al., 1994). The system was tested and operated for approximately 160 hours between September 17 and October 20, 1992. Operations were conducted on a daily basis with as many as four two-hour flights a day. Replicate tests were performed during seven sets when tuna and other fish were captured. A total of 2,002 data files were recorded during 44 helicopter flights. Ninety-one files were selected for review and 13 files were selected for demonstration and discussion. The system was able to detect sub-surface fish as deep as 17 meters (50-55 feet) and to detect and display accurate profiles of shallow, turbid, near-shore areas of the sea as deep as 24m (75-80 feet).

Remote Sensing Industries Inc. (RSI), was awarded two primary contracts during 1990 (52ABNF000126) and 1991 (43ABNF200692) for the initial development of an "OSPREY" LIDAR system. RSI subcontracted part of the effort to Dr. Gerald Grams and Mr. Clyde Wyman of Grams Environmental Labs. During 1992, Grams Environmental Labs was awarded a contract to modify the "OSPREY" system and test a "LIDAR.C" system aboard a purse-seine vessel (43ABNF201797).

Although a protest concerning the development process, contract awards, and ownership rights to the hardware and software was

raised, RSI and the National Oceanic and Atmospheric Administration reached an agreement that provides government ownership of all existing hardware and commercially purchased software, authorizes RSI to copyright "OSPREY" software developed by RSI under contracts 52ABNF000126 and 43ABNF200692, and grants the government and others acting on the Government's behalf a license to reproduce any developed software, prepare derivative works, and publicly perform and display this software.

The purpose of this report is to describe the latest software incorporated into the "LIDAR.C version 1.4Q" system modified after the sea trials and provide listings of the source code as of March 1993. This report is agumented by a description of the earlier "LIDAR.C" software (version 1.20) used during the sea trials and provided by the contractor when the computer returned from the sea trials (Oliver 1994), a technical report on the development and operation of the systems (Oliver et. al., 1994), and the contractor's final report (Grams and Wyman, 1993).

A schematic diagram of the NMFS-LIDAR hardware is shown in Figure 1. An interactive, menu-driven, computer program ("LIDAR.C") controls operation of the system and allows an operator to select from a variety of functions (Figure 2). A "RECORD LIDAR DATA" function provides the ability to observe a real-time display of the laser echoes as they are processed, and provides the operator with the capability to "tag" a specific echo for later review and analysis. A "REVIEW LIDAR DATA" function can be used during or after a flight to replay archived data. Figure 3 shows a black-and-white reproduction of a color display of bottom contours obtained by the "LIDAR.C v1.40" system, and Figure 4 shows a display in which fish were detected.

Computer Directories

The contractors returned the "LIDAR.C" computer at the completion of the sea trials in October 1992. The files on the computer's harddisk were reviewed and directories and files that were not considered part of the system were deleted. The entire harddisk was then archived using the existing Colorado Memory Jumbo 120 Tape Backup System. The schematic in Figure 5 shows the structure of the computer's directories on its "C"-harddisk. A brief description of the contents of these directories follows.

UTIL contains software that are not critical to the "LIDAR.C v1.40" system, but are useful. These include "editor", "disk parking", "data compression", "screen saver", "clock set", and "file finder" utility programs. The "LIDAR.C v1.40" system makes use of **PKZIP.EXE, PKUNZIP.EXE, and SETCLOCK.BAT**

DATA is the directory where the "LIDAR."C" program creates new data files when in the "RECORD LIDAR DATA" mode. It is also the directory where data files must reside if one is to use the "REVIEW LIDAR DATA" mode. There are currently two compressed files in this directory which should be de-compressed (using

PKUNZIP.EXE) before executing the "LIDAR.C v1.40" software to "REVIEW LIDAR DATA". File **LIDAR92.ZIP** contains 91 data files (23 megabytes) of data. File **DEMOFILE.ZIP** contains 13 data files (3.3 megabytes) of data. These 13 data files are also included in the 91 data files contained in LIDAR92.ZIP.

DOS contains files for Microsoft Corporation's MSDOS 5.0 operating system.

ROOT contains backup copies of various "autoexec.bat" and "config.sys" macros, and associated macros (e.g., LID.BAT), to invoke an appropriate **"AUTOEXEC.BAT" and "CONFIG.SYS"** depending upon the operation to be performed.

GWG.BAT is used to execute the LIDAR software with all functions available.

LID.BAT is used when developing or modifying LIDAR software and during compilation and linking.

REG.BAT is used to execute the LIDAR software and only review data.

TAPE.BAT is used when archiving or retrieving data using the Colorado Memory Tape Backup System.

TAPE contains the Colorado Memory Tape Backup System software (version 3.3).

AT-GPIB and its sub-directories contain all the files packaged with the National Instruments AT-GPIB board. During execution, this directory contains a file needed for the AT-GPIB board to communicate and read data from the digital oscilloscope (e.g., **GPIB.COM**). The file **AT-GPIB\MCIB.OBJ** was packaged with the Tektronix digital oscilloscope and is needed for operation of the "LIDAR.C v1.40" system. **IBDIAG.EXE and IBCONF.EXE** are routines provided by National Instruments for testing their AT-GPIB board. The contractors used these routines to test the system when is was first being put together. They are not needed to run the software and could be deleted (and any reference to the programs in the LIDAR software).

MOUSE contains a compressed file for installing and using a "mouse driver software release 3.4". A mouse was packaged with the computer but was not incorporated into the "LIDAR.C v1.40" system.

GWG is the directory from which the "LIDAR.C v1.40" or any other version (e.g. "OSPREY") software is executed. There are five sub-directories under **GWG** (Figure 5). Four of these contain "LIDAR" programs and one contains "LIDAR" data. To invoke a particular "LIDAR" program, one should first delete all the files that exist in the directory **GWG** and then copy all of the files to directory **GWG** from the appropriate sub-directory (e.g., GWG\LIDAR92). Similarly, one should copy data files from the **BESTDATA**

subdirectory to the main directory **DATA** as required by the current "LIDAR" programs.

Sub-directory **GWG\BESTDATA** is a storage directory for data files (e.g., LIDAR92.ZIP and DEMOFILE.ZIP).

Sub-directory **GWG\LIDAR92** contains the software for the "LIDAR.C v1.20" program that was used during the sea trials in September and October 1992. This software created all of the data files during the sea trails as part of contract 43ABNF201797.

Sub-directory **GWG\LIDAR93** contains software for the "LIDAR.C v1.40" program that was modified after the sea trials. The contractor believes he only added functions to the software, and that it should still be able to collect data as the earlier version. However, I have only verified that this version of the software will allow one to "REVIEW LIDAR DATA". This software was also created as part of contract 43ABNF201797.

Sub-directory **GWG\OSPREY91** contains software (but no source code) for an earlier version of the "OSPREY-1" software. This software is not capable of using data files collected during the sea trials. There are five (5) data files in this sub-directory that were provided by Dr. Grams on August 6, 1991. These files represent data collected during tests in May 1991 under contract 52ABNF000126.

Sub-directory **GWG\OSPREY93** contains files provided by Dr. Grams on March 11, 1993. Files in this sub-directory represent the version of software referred to as "OSPREY-2", "OSPREY-3", or "OSPREY-C" at the conclusion of contract 43ABNF200692 in May 1992. This software is capable of displaying data files collected during the sea trials but not those associated with the earlier "OSPREY-1" software.

XR4GPS and its sub-directories contain all of the software packaged with the NavStar Ltd., XR4-PC geophysical positioning system. The subdirectory **XR4GPS\TERMINAL** includes files needed to initialize and run the NavStar XR4-PC board (e.g., **TERMXR4.EXE and XR4DEV.SYS**).

ZORTECH and its sub-directories contain all of the files associated with the ZORTECH C++ Version 2.0 programming language, compiler, and debugger purchased by the contractors to develop the "LIDAR.C v1.40" software. File **ZORTECH\INCLUDE\FG.H** is a "C"-language routine incorporated into the "LIDAR.C v1.40" system by Dr. Grams. It is packaged with the ZORTECH software and required during compilation and linking to produce the two-dimensional displays.

Special Software

C_GWG.LIB is a "C"-library file with routines that produce menus and data entry screens for selecting various program functions, selecting data files to review, and other keyboard control functions in the "LIDAR.C v1.40" program. These files provide "bullet-proof" user interactions with "pop-up" windows and other convenient features that are the result of many years of effort at Grams Environmental Labs. Examples of calls to these library functions are wndw_menu_titl(), wndw_menu_line(), wndw_menu(), wndw_one_line(), etc. These library files were provided to NMFS under contract 43ABNF201797. However, the source code is considered 'proprietary' by Grams Environmental Labs and is not to be distributed. Dr. Grams provided NMFS with a written description of these functions so that a computer programmer could create new routines to perform the same functions.

LINK.EXE is a Microsoft Overlay Linker (Version 3.64) chosen by the contractors to "link" the object files and library files needed to produce the executable program (LIDAR.EXE) from the "LIDAR.C v1.40" software. This "linker" may not be required by the current system. Dr. Grams subcontracted the creation of a "driver" for the Tektronix digital oscilloscope. The person who did this work used this "linker" because of some problems he encountered in attempting to "link" object files generated by the Microsoft C compiler (e.g., drivers for the National Instruments AT-GPIB board) with object files generated by the version 1.0 Zortech compiler. In retrospect, Dr. Grams believes the version 2.0 Zortech linker can be used, but neither he nor I have verified if this is true. Dr. Grams provided the "linker" under contract 43ABNF201797.

PCFILE.EXE is a "public domain" program that has been used to review the names of the files in the "**DATA**" directory. It allows one to review filenames and delete files. It is not critical to the operation of the "LIDAR.C v1.40" system. Dr. Grams obtained this program and provided it to NMFS under contract 43ABNF201797.

"LIDAR.C version 1.40" Software

Dr. Grams provided much of the following as documentation of the software in a letter dated February 19, 1993. These descriptions refer to files located in the directory **GWG\LIDAR93** (Table 2). Listings of the source code for programs and macros are available.

AUTOCONF.TXT is a listing of the AUTOEXEC.BAT and CONFIG.SYS files that were used when the LIDAR.EXE was executed and all functions were active. If modifications are incorporated into the software, the programmer should perform the **SETZTC.BAT** actions before compiling the programs, and then reboot the computer. If one only wants to review existing data, then access to the **XR4GPS and AT-GPIB** directories is not required.

C_GWGLIB.DOC is the text of a letter Dr. Gerald Grams provided NMFS on March 12, 1993. The letter provides a description of the functions performed by the "C"-library file **C_GWG.LIB**. I have included the text of his descriptions in the "Program Listings" section so that the functions contained in the library can be recreated by another programmer should any modifications be necessary.

C_STDPC.H is a header file needed to compile the "LIDAR.C v1.40" source code.

CTAG.GWG is a file that contains "tag numbers" associated with specific data files. The "LIDAR.C v1.40" software creates a new "CTAG.GWG" file in the default C:\DATA directory if one does not exist. As data files are created and "tags" are requested, this file is appended. The file provides the capability to rapidly select and review specific data files and/or specific "tags" when reviewing data.

DFLT.DAT is a text file produced by one of the C_GWG.LIB routines which is used to select colors used by the "Pop-up" window menus and store default values of various system parameters. This file is created whenever the software is executed, whether or not it existed in the subdirectory prior to execution.

FG.H is a "C"-language routine incorporated into the "LIDAR.C v1.40" system by Dr. Grams. It is packaged with the ZORTECH software and required during compilation and linking to produce the two-dimensional displays.

LIDAR is a macro that will cause the necessary programs to be compiled (if they are not already compiled) and then link all of the required files to create an executable (LIDAR.EXE) program of the "LIDAR.C v1.40" software.

LIDAR.C v1.40 is the source code for the software that controls the NMFS LIDAR system. This source code was supplied to NMFS during March 1993, and is not the software used during the sea trials (LIDAR.C v1.20). Substantial changes and improvements were made to the software during the tests that were conducted in Panama prior to the sea trials aboard the purse-seine vessel CAPT VINCENT GANN during October 1992. During 1993, additional changes were made to software to enhance the review of data during analysis. These changes exist in the "LIDAR.C v1.40" software. Thus, there are two versions of "LIDAR.C" software. Both should be able to replicate the data collection and operations that occurred during the sea trials, but without testing I am unable to verify this claim.

LIDAR.OBJ, LIDAR.MAP and LIDAR.EXE are produced by the Zortech C++ compiler. The macro **TRYL.BAT** will cause the source code to be complied. The macro includes a call to a **"MAKE" file (LIDAR)** which determines whether or not it is necessary to recompile any of the object files before creating the executable file.

LIDARTAG.C is a "C"-language routine incorporated into the "LIDAR" system to allow an operator to place a "tag" within a data file as it is created. Dr. Grams "linked" this routine to the "LIDAR.EXE version 1.20" used during the sea trials **C:\GWG\LIDAR92\LIDAR.C**)., but later incorporated the function into the source code for the latest version of the "LIDAR.EXE version 1.40" program (e.g., **C:\GWG\LIDAR93\LIDAR.C**).

LOOK.BAT is a macro that can be placed into an AUTOEXEC.BAT macro so that when a computer is booted a user is placed in the directory C:\GWG and prompted to enter "LIDAR" to start the program.

MCH.DOC is a single page of documentation provided by Dr. Grams that addresses **ZTC.BAT, CONFIG.SYS, ZDECL.H, LINK.EXE, and GPIB.COM**.

SETZTC.BAT is a macro that must be executed before attempting to compile and link the "LIDAR.C v1.40" software. This macro "sets up" the computer's configuration and directory path so that the required software is available during compilation. Generally, the computer is then rebooted before executing the LIDAR.EXE program because of memory limitations.

TEK2431L.C is the source code for reading the TEKTRONIX 2431L digital oscilloscope that is used to digitize the LIDAR signals.

TEK2431L.OBJ is the object code generated by the Zortech C++ compiler when the macro **TRYL.BAT** is executed.

TRYL.BAT is a macro that will cause the necessary programs to be compiled (if they are not already compiled) and then link all of the required files to create an executable (LIDAR.EXE) version of the "LIDAR.C version 1.40" software.

ZDECL.H is a header file needed to compile the **TEK2431L.C** source code.

To invoke an executable version of the software:

```
CD C:\
C:\REG.BAT "COPIES THE APPROPRIATE AUTOEXEC AND CONFIG FILES"
"reboot computer"
LOOK.BAT or LIDAR.EXE
"the program will start and look for data files in C:\DATA"
```

To modify the software and then create an executable version:

```
CD C:\
C:\LID.BAT "COPIES THE APPROPRIATE AUTOEXEC AND CONFIG FILES"
"reboot computer"
CD C:\GWG
```

To use the Colorado Memory Tape Backup System efficiently:

```
CD C:\
C:\TAPE.BAT "COPIES THE APPROPRIATE AUTOEXEC AND CONFIG FILES"
"reboot computer"
CD C:\TAPE
TAPE.EXE
"the tape software will start"
```

Acknowledgments

This report provides a description of computer software (LIDAR.C version 1.40) used to control an airborne LIDAR system for detecting fish schools. The software and system were developed for the U.S. Government under a series of contracts between 1990 and 1993. Mr. Brian Treadwell, President of Remote Sensing Industries Inc., approached NMFS with the idea of developing an airborne LIDAR during 1990 in response to inquiries. Mr. Treadwell was instrumental in promoting the idea of using a LIDAR in this fisheries' application. Although many people and companies contributed to the development, two individuals are responsible for the design, construction, operation, and analysis this LIDAR system. Dr. Gerald Grams has been using lasers and designing LIDAR systems for over 20 years and developed virtually all of the computer code for this system. Mr. Clyde Wyman has built and operated LIDAR systems for an equal time and operated the system during the sea trials. I wish to acknowledge their essential contributions to the implementation of this technology to a fisheries' application, and their willingness to unselfishly share their knowledge and ideas with us. Thank you Gerry and Clyde.

Literature Cited

DeMaster, D.P. 1992. Strategic plan to to develop and evaluate "dolphin-safe" methods of fishing for yellowfin tuna in the eastern tropical Pacific. Southwest Fisheries Science Center Administrative Report No. LJ-92-16, Southwest Fisheries Science Center, La Jolla, CA.

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Table 1. Archival of data files recorded during field tests in Panama and aboard the tuna purse-seine vessel CAPT VINCENT GANN during September and October 1992. A total of 2,002 data files (495 megabytes) were collected.

NAME	EXT	START	FINISH	FILES	FULL-SIZE	ZIP-SIZE	J120 TAPE	J250 TAPE
PAN918	918	123744	133724	40	9,881,088	6,623,412	PANAMA	NMFS4
PAN919	919	021358	030602	38	9,473,792	5,296,003	PANAMA	NMFS4
PAN920	920	091753	103319	61	14,898,816	10,603,996	PANAMA	NMFS4
PAN921	921	120113	131604	55	13,831,398	9,884,025	PANAMA	NMFS4
PAN922	922	103227	150753	66	15,581,014	4,720,935	PANAMA	NMFS4
TUNA1	925	113946	171735	17	4,098,560	2,387,562	NOAA1	NMFS1
TUNA2A	926	095433	113950	128	32,027,008	18,191,976	NOAA1	NMFS1
"	926	071612	090519	"	"	"	NOAA1	NMFS1
TUNA2B	926	131929	170317	90	22,434,256	13,070,901	NOAA1	NMFS1
TUNA3	927	055841	104839	35	8,320,442	5,377,264	NOAA1	NMFS1
TUNA4	928	005232	023036	59	14,724,608	11,425,792	NOAA1	NMFS1
TUNA4B	930	093217	170752	91	22,287,575	18,403,441	NOAA2	NMFS1
TUNA5	A05	055102	060056	106	26,273,455	19,176,293	NOAA2	NMFS1
"	A06	063911	014752	"	"	"	NOAA2	NMFS1
"	A07	065059	071649	"	"	"	NOAA2	NMFS1
"	A07	143315	144720	"	"	"	NOAA2	NMFS1
"	A07	024931	035400	"	"	"	NOAA2	NMFS1
TUNA7	A09	063027	094244	43	10,816,384	7,813,776	NOAA2	NMFS1
TUNA8	A11	073548	120742	133	33,568,063	15,687,246	NOAA3	NMFS3
"		021906	023347	"	"	"	NOAA3	NMFS3
TUNA9	A12	065300	112021	179	45,361,020	25,646,327	NOAA3	NMFS3
"	A12	023505	042344	"	"	"	NOAA3	NMFS3
TUNA10	A13	082547	164215	115	29,114,196	16,802,486	NOAA3	NMFS3
TUNA11A	A14	080647	121436	136	34,256,907	26,585,800	NOAA4	NMFS2
TUNA11B	A14	134201	144056	43	10,075,787	7,972,611	NOAA4	NMFS2
TUNA11C	A14	153140	171312	69	17,162,891	13,365,803	NOAA4	NMFS2
TUNA12A	A15	073135	084306	59	14,628,809	10,594,021	NOAA4	NMFS2
TUNA12B	A17	083107	173754	121	30,232,366	21,956,200	NOAA5	NMFS2
TUNA13A	A16	110022	115134	43	10,896,768	8,342,388	NOAA5	NMFS2
TUNA13B	A16	143721	173718	83	20,931,287	15,863,850	NOAA5	NMFS2
DATA19A	A19	062425	074912	40	9,781,632	5,652,096	NOAA6	NMFS4
DATA19B	A19	103544	110605	18	3,952,035	2,410,298	NOAA6	NMFS4
DATA19C	A19	113618	145913	33	7,317,011	4,096,899	NOAA6	NMFS4
DATA19D	A19	150030	160050	46	11,331,384	6,551,204	NOAA6	NMFS4
A20	A20	091453	170941	55	12,275,160	7,244,269	NOAA6	NMFS4
				2,002	495,533,712	321,746,874	7	4

Table 2. NMFS "LIDAR.C version 1.40" files provided by Dr. Gerald Grams under contract 43ABNF201797. These files were not used to collect data during sea trials but were extensively modified to provide enhanced displays.

Directory of C:\GWG\LIDAR93

AUTOCONF	TXT	1139	04-08-94	2:37p
C_GWG	LIB	88064	12-27-91	9:03a
C_GWGLIB	DOC	21376	04-07-94	2:03p
C_STDPC	H	2816	01-18-93	4:37p
DFLT	DAT	219	04-08-94	3:06p
FG	H	17407	09-18-90	2:54p
IBCONF	EXE	101297	04-05-91	4:52p
IBDIAG	EXE	70765	04-05-91	4:52p
LIDAR		256	02-17-93	1:51p
LIDAR	C	49152	09-12-93	12:15p
LIDAR	EXE	106758	04-11-94	9:53a
LIDAR	MAP	4428	04-11-94	9:53a
LIDAR	OBJ	30137	04-11-94	9:53a
LIDARTAG	C	1536	09-21-92	10:59a
LINK	EXE	65475	02-01-88	1:00p
LOOK	BAT	128	09-20-92	10:22a
MCH	DOC	1289	04-09-91	12:03a
MCIB	OBJ	5486	04-05-91	11:16p
PCFILER	EXE	48468	03-29-86	12:54p
SETZTC	BAT	1152	11-17-92	8:06a
TEK2431L	C	19968	12-27-91	3:21p
TEK2431L	OBJ	15682	04-11-94	9:53a
TRYL	BAT	128	01-18-93	12:53p
ZDECL	H	15928	04-08-91	9:57p

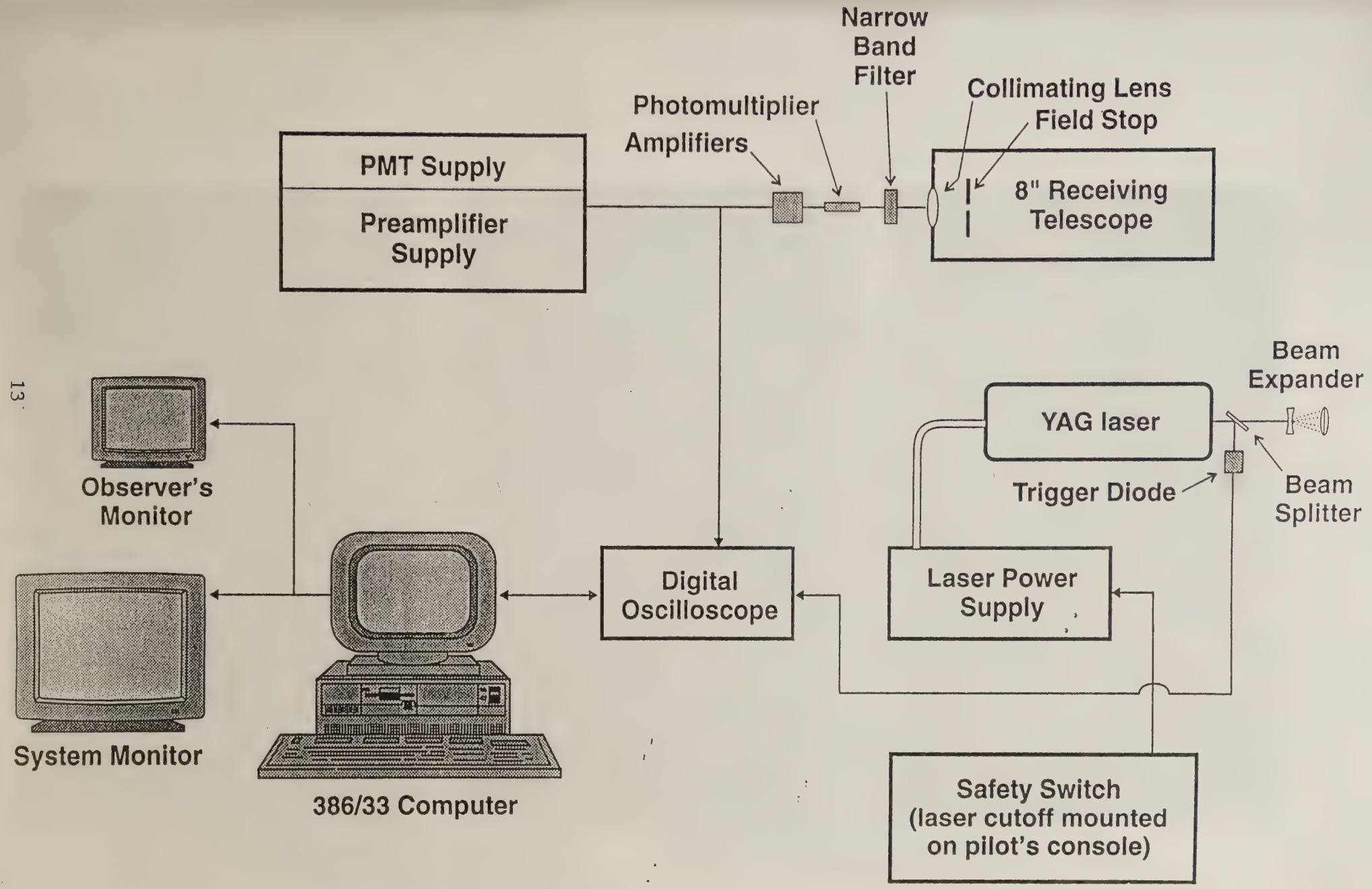
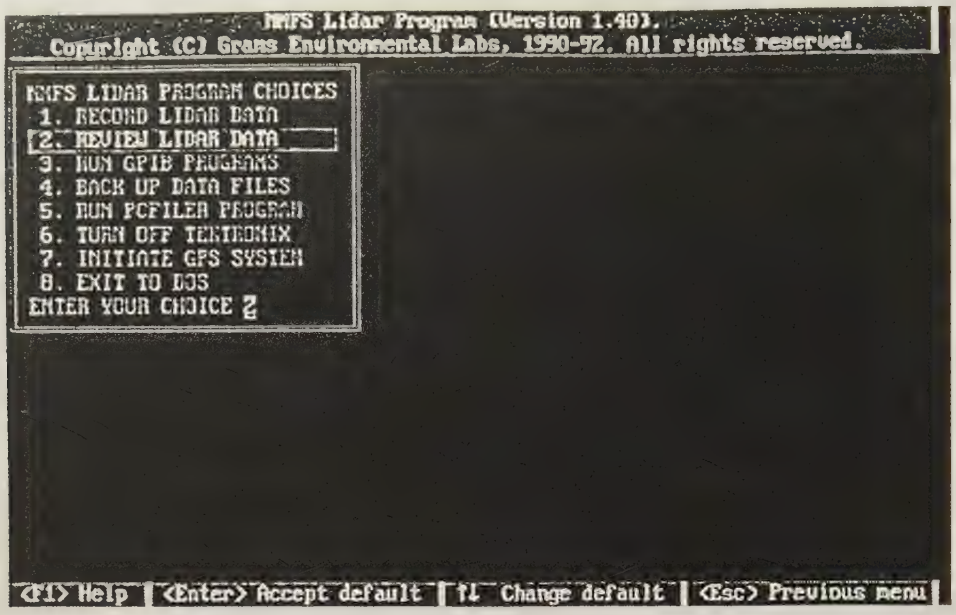
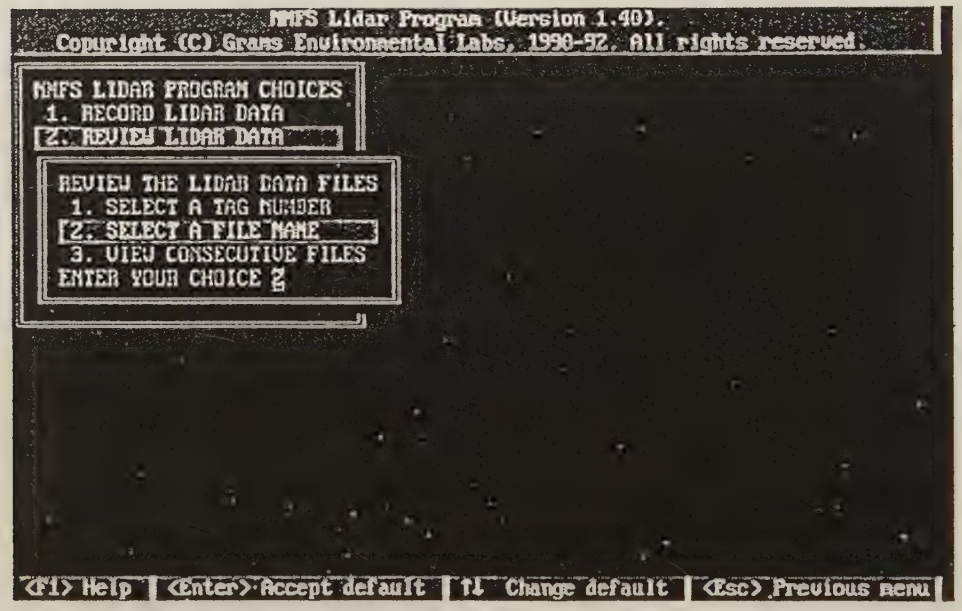

Narrow
Band
Filter
Photomultiplier
Amplifiers
Collimating Lens
Field Stop
PMT Supply
Preamplifier
Supply
8" Receiving
Telescope
Beam
Expander
YAG laser
Trigger Diode
Beam
Splitter
Observer's
Monitor
Digital
Oscilloscope
Laser Power
Supply
System Monitor
386/33 Computer
Safety Switch
(laser cutoff mounted
on pilot's console)

Figure 2. Menu screen options for the NMFS "LIDAR.C version 1.40" software program.




NMFS Lidar Program (Version 1.40).
Copyright (C) Grams Environmental Labs, 1990-92. All rights reserved.
NMFS LIDAR PROGRAM CHOICES
1. RECORD LIDAR DATA
2. REVIEW LIDAR DATA
REVIEW THE LIDAR DATA FILES
1. SELECT A TAG NUMBER
2. SELECT A FILE NAME
3. VIEW CONSECUTIVE FILES
ENTER YOUR CHOICE 2
<F1> Help
<Enter> Accept default
↑↓ Change default
<Esc> Previous menu

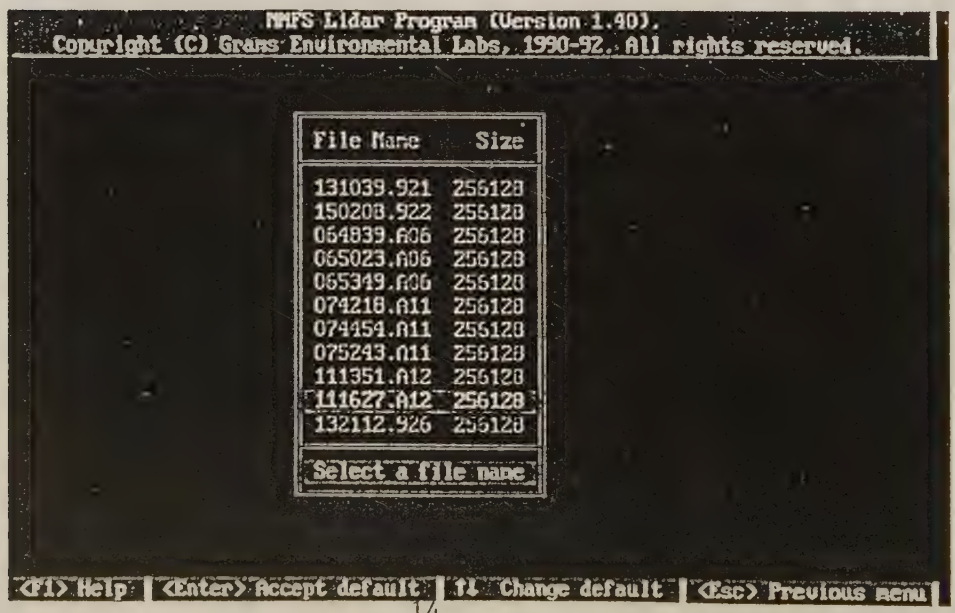


Figure 3. LIDAR display of bottom contour in "expanded mode" from file 150208.922 showing a detected depth of 18 meters at pulse 209 (Figure 3A) rising to a detected depth of 6 meters at pulse 325 (Figure 3B).

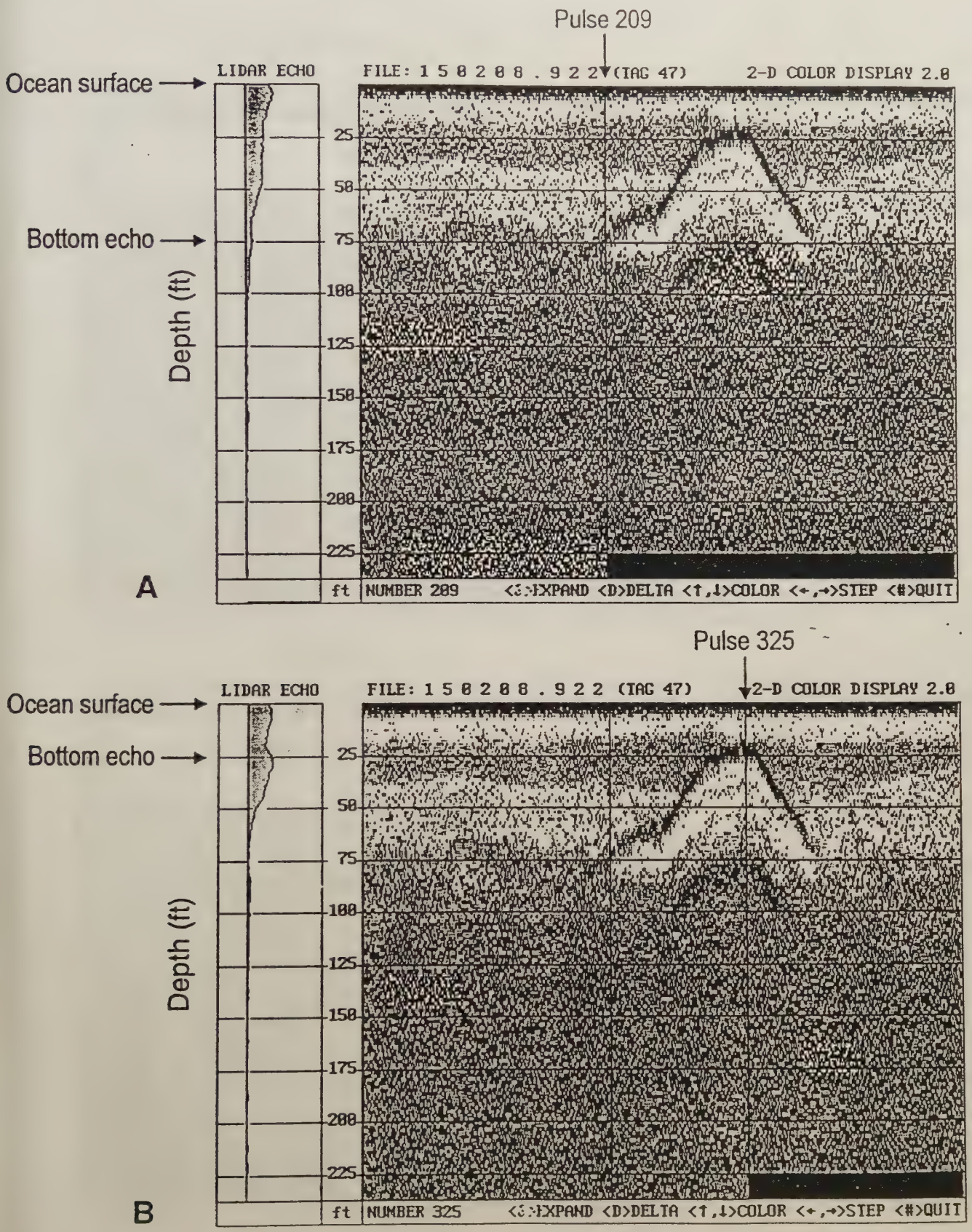


Figure 4. LIDAR display of fish school in "expanded mode" from file 111627.A12 showing subsurface fish detected at depths between 9-15 meters at pulse 285 (Figure 4A) and between 11-17 meters pulse 288 (Figure 4B).

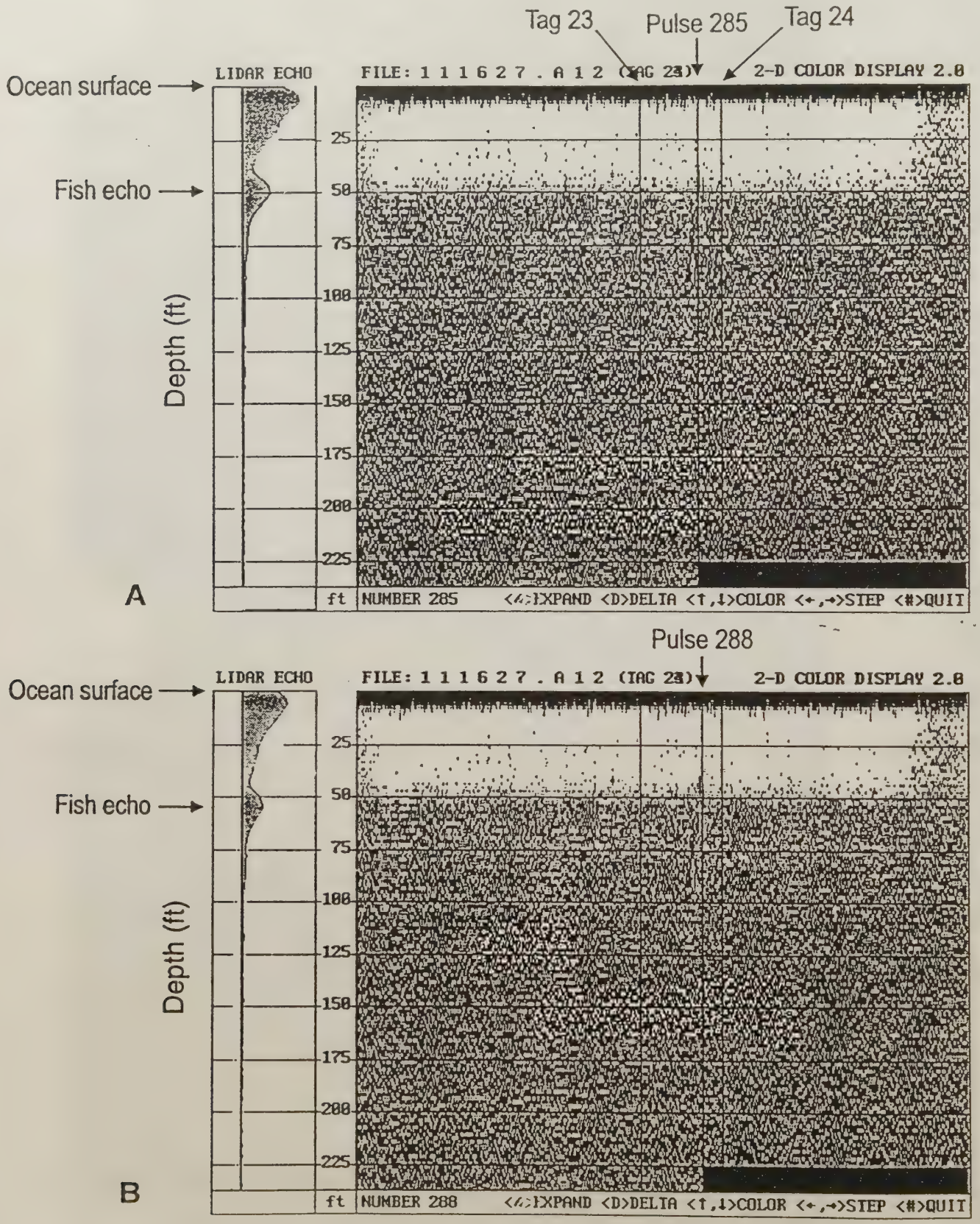
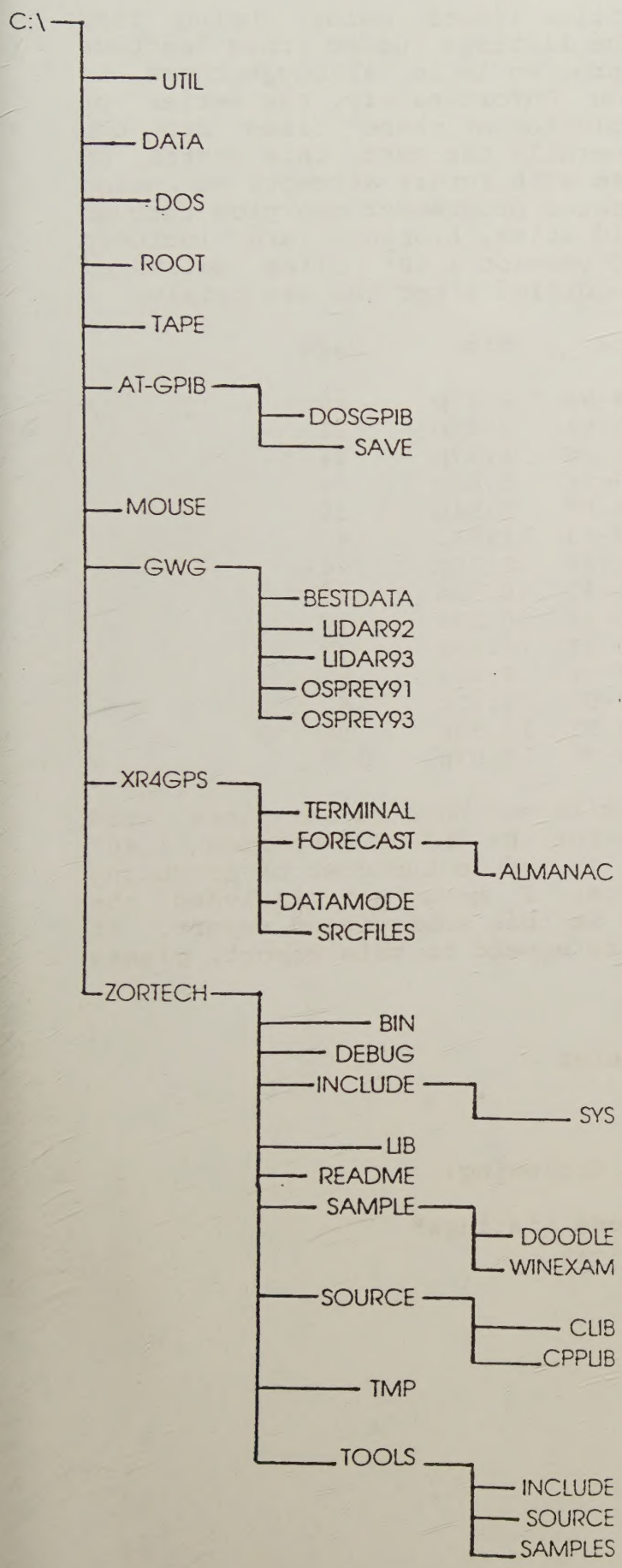


Figure 5. Directory structure for the NMFS "LIDAR.C" computer.



Program Listings

Dr. Gerald Grams provided the files listed below during 1993 under contract 43ABNF201797. The listings under this section should help one understand the program logic, although there is very little internal documentation. Unfortunately, the series of contracts which led to the evolution of these files did not require documentation. As is generally the case, this dearth of documentation can be a big problem with future attempts at using the software. Hopefully, a dedictated programmer can plow through these listings if the need should arise. Listings are included for the following NMFS "LIDAR.C version 1.40" files delivered under contract 43ABNF201797 and modified after the sea trials.

File		Size(kb)	Date	Time	Page
AUTOCONF	TXT	1139	04-08-94	2:37p	19
C_GWGLIB	DOC	21376	04-07-94	2:03p	21
C_STDPC	H	2816	01-18-93	4:37p	31
DFLT	DAT	219	04-08-94	3:06p	34
FG	H	17407	09-18-90	2:54p	35
LIDAR		256	02-17-93	1:51p	45
LIDAR	C	49152	09-12-93	12:15p	46
LIDARTAG	C	1536	09-21-92	10:59a	74
LOOK	BAT	128	09-20-92	10:22a	77
MCH	DOC	1289	04-09-91	12:03a	79
SETZTC	BAT	1152	11-17-92	8:06a	81
TEK2431L	C	19968	12-27-91	3:21p	83
TRYL	BAT	128	01-18-93	12:53p	98
ZDECL	H	15928	04-08-91	9:57p	100

NOTE: Because most individuals will not have an immediate need to review the actual source code for the "LIDAR.C version 1.40" software, and the NMFS would like to reduce the cost of producing copies of Administrative Reports, **I have not included the "Program Listings" (Pages 19-106) in this abbreviated report. If you desire the complete listings to append to this report, please send a written request to:**

LIDAR Custodian
Southwest Fisheries Science Center
P.O. Box 271
La Jolla, CA 92038-0271.

Your request should reference the following:

"LIDAR.C version 1.40 Source Code Listings"
Administrative Report No. LJ-94-16
Oliver 1994